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THE MUSIC OF COLOR.

By C. E. Seth Smith.

> "There's not the smallest orb that thou beholdest
> But in his motion like an angel sings
> * * * * *
> Such harmony is in immortal souls."
> * * * * *
>
> *Merchant of Venice*, Act V., Scene 1.

The music of the spheres is an ancient story standing in evidence of an apprehension which has always obtained of the harmony of physical phenomena. That the heavenly bodies as bestowers of light give at the same time the harmonies of sound is the notion thus vaguely signified.

This conception, which has for so long a time haunted the human understanding, is by the evolution of scientific facts no longer vague. That there is an analogy between the impression produced by a musical composition and that produced by a painting is undoubted, and has from time to time occupied the attention of both musicians and painters. It remains only for a collocation of such facts as have been in very recent times obtained by the study of the elementary principles of Music and, by means of the prism and spectroscope, of the properties of Light, to demonstrate not only the dependence of both color and sound upon analogous vibration, but that between the laws regulating the *composition* of the one and the other there exists a definite and systematic relationship.

It is the purpose of this paper, through the means now available to science, to give the theory of this relationship; thereby placing beyond the region of doubt the existence of a precise mathematical harmony between the Arts which appeal most potently to man's æsthetic nature — Music and Painting.

Light and Sound are known as attributes of motion, called by one or the other name as the respective organs translate that motion in different ways to the brain; a certain number of regularly recurring motions combined into a single impression giving the sensation of Sound, another set in more numerous proportion giving that of Light.

It must be remembered that these wave-motions have limits, at either end of which certain other vibrations exist, which are untranslatable by the brain either as color or sound.

This limitation, however, is not constant, and differs in various species of animals, in individuals, and even in the dual organs of the man.

Within the recognized limits in the case of sound, those having vibrations from 16 to 38,000 per second, there are some which individual ears detect, which to others are unheard.

Doctor Wollaston has shown that the power of the ear varies much in different persons, and that to many the shrill notes of the cricket and the bat are inaudible.

One ear is often less sensitive than the other in the same person.

The range varies in animals also, and with it the power of producing as well as hearing sounds.

M. Savart has pointed out that the ear of a calf is so constructed that the lowest sounds only are heard, and that its limit must necessarily be *beneath* ours. The lowing of cattle, doubtless, impresses themselves far differently from the impression made on us. Their quick detection of movement inaudible to human beings assists this conjecture. At the higher limit, too, we may instance many insects who both hear and produce sounds shrill beyond our cognizance.

The same variation is found in the power of sight; waves at each end of the spectrum have been demonstrated—heat rays at the lower or red end, and actinic or chemical rays at the higher or violet end, both of which are quite powerless to affect the retina of the eye. Tyndall has shown by experiment that some of these invisible calorific rays brought to a focus, and energetic enough to raise platinum to a red heat, do not cause the optic nerve, placed at the same spot, to be conscious of either light or warmth.* With this "personal" equation distinctly in view, where can the absolute limits of Sound or Light be placed? How rapidly or slowly must motion vibrate to produce that which is neither Light nor Sound? Logically such limits are impossible; that there is a limit to the eye and ear, to each organ, is true; but the fact that this limit so varies in individuals admits the hypothesis, that to a perfect organ the perception of motion is illimitable.

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* Science for Unscientific People, p. 194.

A tuning-fork in agitation, held loosely in the hand, yet produces sound—inaudible, indeed; but, placed upon a firm, resonant base, from the same play of the limbs of the fork a clear full note swells out. The fibres of the wood or other substance are also imbued with motion, and take up and repeat with greater force the silent note of the tuning-fork.

It is to this power of sympathy or synchronism in various bodies and in the air that the impressions translated to the brain as sound are due; and by this synchronism may we understand the true nature of all sensations.*

The vibration of a column of air in a jar responsive to an approaching tuning-fork, and the dancing of "sensitive flames," are due to this power of synchronism.† These vibrations, communicated through various channels, eventually reach the brain, where they are conceived and called Sound.

Chladni has shown that, though the ears be stopped, two persons may converse by stretching a thread between the teeth, or pressing a stick against the breast or throat. Thus may the true manner in which sonorous motion is conveyed to the brain be understood.

By watching the strings of a piano, it may be noticed that whenever a note is sung in a room, that note which represents the same note is thrown into vibration. A deaf man may be so placed as to hear every note that has been sung.

An instrument which acts under the same influence has been discovered in the ear by the Marchese Corti, and which is shaped like the harmonicon. Wedge-like in structure, it divides the cochlea of the ear, and is so constructed that the individual fibres can execute vibrations without throwing the remainder of the membrane into vibration. This wedge-shaped structure is stretched in the direction of its breadth, so that its fibres form a series continually diminishing. These fibres were examined in 1869 by Professor von Heusen of Kiel, and by Helmholtz proved capable of executing the movements suggested.

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* Tyndall on Sound, p. 321.

† Philosophical Magazine, 1867.

We are thus led to conclude that it is the limit of the organs in the ear which alone limits the vibrations of motion being translated by it as sound—since all motion is in a condition to produce Sound; all Motion is Rhythmical, a series of undulations of waves to and fro.

Herbert Spencer* proves the rhythm of motion by illustration of natural effects—by the waving of pennants, the vibration of cordage, the sound from an æolian harp, the waving of water-weeds, the rippling of shallow streams and the serpentine course of rivers, the rapid rhythm of the screw of a steamer, and the lateral and vertical oscillations of a railway carriage.

All known forces, too, serve as examples; for Light, Heat, and Electricity, are all propagated by undulations.

The Northern Aurora and the stratification in vacuum tubes shows that the current is not uniform, but comes in gushes of greater or less intensity. In Sound we have interference and beats; in Light, the twinkle of the stars—both resulting from the same cause.

From the production of little ridges in the sand, when the tide is running down, to the rolling of the planets as they alternately present each pole to the sun, all motion is traceable only in a state of vibration.

Even in sensations which expend themselves in the production of Music, Dancing, or Poetry, this is seen—strong muscular efforts in dancing being alternated with weaker—Bars, Piano-forte, and the primary and secondary beat, marking out the Rhythm of Music.

Poetry, even, may be said to be "a form of speech which results when the emphasis is regularly recurrent—that is, when the muscular effort of pronunciation has definite periods of greater or less intensity, periods which are complicated with others of a like nature answering to the successive verses."

Pain has fits of intensity, and Passion comes in bursts.

Since, then, it must be granted that all motion is in a State of Rhythm, a state capable of producing sound—were the organ of hearing sufficiently extended—the following question arises: are the *pleasing combinations* of these motions such as might be inferred from a study of Musical laws? Will experiment bear out the inference and show that *all* harmonies result from obedience to similar conditions?

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* First Principles, Part 2, chap. xi.

To define our terms: since musical combinations which form harmony are not the result of fortuity or accident, but are the consequence of obedience to well-defined mathematical laws, a short statement of these conditions is necessary.

Pythagoras, 500 years before Christ, recommended to students of Music the simple monochord, and with it all the fundamental laws may be illustrated.

A string stretched and then divided into three equal parts, and fixed at one point of division, will, when sounded, give two notes; that portion of the string whose length is just half that of the other will give the octave of the longer portion.

The string again divided into two parts bearing to each other the proportion of 2:3, when sounded will give notes which are separated by an interval called *a fifth.*

Thus dividing the string at different points, Pythagoras found the so-called consonant intervals in music to correspond with certain lengths of the string, and made the extremely important discovery that the simpler the ratio of the two parts into which the string was divided, the more pleasing was the harmony of the two sounds.

Two notes one of which is the octave of the other blend the most pleasingly together—their ratio is written down as 1:2; next to them, a note and its fifth, written as 2:3; the next most pleasing, a note and its fourth, whose ratio of vibration is 3:4—and so on, each combination growing gradually from incipient roughness to absolute discord, until, when the ratio of 13 to 14 is reached, interference is marked by beats, and the ear testifies its repugnance to so complex a relation of one note to another. The question to be mooted now comes in: since the harmonies—that is, the pleasing combinations of Music—follow a regular mathematical law, will not the result of Motion in other forms—in that of Light—exhibit in its harmonies any obedience to the same or analogous laws?

Modern Scientific investigation already proves how all known forces act in accordance with similar laws, the phenomena of any one illustrating the others, the difference being only in degree. Analogies between Nerve-force and Electricity, Electricity and Heat, Heat and Light, Light and Sound,* are everywhere admitted; why not, then, an analogy between the Arts built upon those scientific laws if one exist between the forces themselves?

Since obedience to the laws of Sound produces in Music pleasurable harmony, and obedience to the laws of Light produces in Painting a pleasurable composition, is not an analogy between Music and Painting as truthful as one between Sound and Light?

The means of producing both sound and light are in comparison alike. By striking a tuning-fork, by plucking a string, by hammering, Sound is produced, as Light by striking flint and steel, or by rubbing together two pieces of wood or quartz.

Light is motion, for it may impart motion to solids, and by its inseparable heating powers it can be made to turn wheels and lift weights.

Waves of sunlight are of different lengths mixed together, and producing, when so mixed, a sensation upon the optic nerve called "white light." This nerve, like the musical instrument in the ear, spreads out to form the retina, and has upon its terminal filaments most minute bodies termed the "rods and cones." Each of these, Melloni has suggested, accepts only the vibrations of that impinging Light-wave which synchronizes with its own; sympathetic vibration, in short, being the cause of the sensations of both Light and Sound. The waves of sunlight, by means of the prism, may be separated from each other and spread out upon a screen, with the longest, or red waves, at one end, the shortest, or blue waves, at the other, and the intermediate gradations orderly arranged between the two extremes.

Color is, in fact, but a phenomenon of wave-length, just as higher and lower notes are the product of shorter or longer Sound-waves.

But there is a great interval, it is said, between the highest Sound and the lowest Color-wave; and another difficulty, in the small range of but one octave which Color possesses, while Sound, taking a much wider range, extends over nearly eleven octaves.

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* Quarterly Journal of Science, January, 1870; and Color and Sound, Dr. Macdonald, F.R.S.

But this difference is only one of degree; each scale is obedient to the same laws, though the vibrations of the one are so vastly more delicate and subtle than those of the other.

It is possible that a painting by Raphael, or the delicate play of colors on a pigeon's breast or on a shot-silk dress, may express as truly a Musical theme as one of Bach's fugues or a symphony by Beethoven. And although the relations causing the latter vary but from 100 to 3,000 times in a second, while in the former they pulsate from 500,000,000,000,000 to 700 million million times in the same period, still the precise relationship existing between the two scales may be so worked out that Painting and the coloring of dress shall be elevated to the status of a science based like Music upon mathematical principles.

The first step towards this definite analogy was discovered by Newton, who found the spaces occupied by the seven principal colors to be similar to the relative intervals between the seven musical notes comprising an octave. And recent investigation has shown that the actual ratio of sound wave-lengths to each other compare with the ratio to each other of wave-lengths of colored light.

New tables have appeared of the wave-lengths of different parts of the solar spectrum,* which require only to have the various wave-lengths reduced to a common ratio and compared with those of musical notes reduced to the same ratio to show a most marked correspondence.

The first column in the table here given represents the actual wave-length of the different *colors* as determined by Professor Listing; the second column gives the ratio of one set of wave-lengths to another taking 100 as the mean; the third column gives the wave-length in inches of the *notes of the middle octave;* the fourth, the ratio of one note to another, taking also as the mean 100.

A most remarkable table is the result, given as follows:

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* Transactions of the Royal Society of Upsala, 3d Series, vol. vi.

						Mean.						Mean.
Red	waves	are	685	of a millim.	in length,	100	C	has waves	52	in.	in length,	100
Orange	“	“	616	“	“	89	D	“	46½	“	“	89
Yellow	“	“	560	“	“	81	E	“	42	“	“	80.8
Green	“	“	513	“	“	75	F	“	39	“	“	75
Blue	“	“	456	“	“	66⅔	G	“	35	“	“	67
Violet	“	“	410	“	“	60	A	“	31	“	“	60
Ultra-violet							B	“	27½	“	“	53

And, doubtless, could we distinguish colors beyond the violet they would repeat themselves, and like the musical scale advance octave by octave with precisely similar notes. We have the high authority of Sir John Herschel and Professor Grassmann* in support of this inference.

The æsthetic analogy between Color and Sound, Painting and Music, is thus founded, and the intuition of this fact, to which Language is already a witness, proved to be truthful.

“Loud,” “*criard*,” “*Schreiend*,” appear identical expressions, applying in English, French and German both to glaring colors and forcible musical sounds.

“Tone” is a term both of coloring and of sounds.

“Dim” and “dumb” in Anglo-Saxon appear closely related, expressing feebleness to either voice or sight.

Max Müller’s researches show that in Sanscrit the word “*Purûravas*,” which means the same as πολυδευκής—endowed with much light—has a root (*ru*) which, although meaning originally “to cry,” is applied also to color in the sense of a loud or crying color.† Thus it is said, “The fire cries with light”; and the rising sun, in the Veda, is said to “cry like a new-born child.”

From time immemorial, indeed, the sister arts have gone hand in hand, and a genius for the one seems to have been inseparable from a genius for the other. The great masters in painting were often at the same time good musicians;

> “Not merely painters dwarfed in all their aims,
> But men who painted, builded, carved, wrote
> Whole diapasons, not a single note.”—*Story.*

But this analogy must be carried further than similarity of production, than innate perception, or than agreement of ratios of wave-lengths, and an absolute identity be shown between the laws laid down by the masters of each art.

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* Philosophical Magazine, April, 1864.

† Chips from a German Workshop, vol. 2, p. 101.

The identity in number of the seven notes in the visible prismatic scale and the seven notes of the musical scale already noticed, and the fact that the three principal colors—Red, Yellow, and Blue—which occur respectively on the first, third, and fifth intervals, and so answer to the chord admitted by all musicians to be the ground-work of harmony, strengthen the analogy.

The most pleasant combination of sounds next to that of unison is of a note and its octave, answering in painting to what is termed Reflection, where the expanse of color in the upper part of a picture is repeated, though in less extent at the foot.

The next combination of sounds in the scale of pleasurable sensations is formed by a note and its fifth, called from its predominance in Music "the Dominant," and answering in the Key of C to G: its analogue will be Blue. Then a note and its fourth, giving Red and Green.

In natural colors, these are the simplest and most accurate combinations. As a broad principle, it may be assumed that alternate colors produce common chords—Red, Yellow, and Blue, answering to C, E, and G; and Orange, Green, and Purple, to D, F, and A.

Given one note—C, for instance, supposed to be the analogue of Red—it should be supported by the other two either separately or in its *complementary* color, Green, answering to F. Purple should have its complementary Yellow, or be supported by Green and Orange.

Thus any key may afford examples, the working out of which will be of great service to those diffident of their own taste. For although good taste in dress, in the arrangement of flowers, and what is called *gusto* in painting, seem intuitive in the same manner as musical taste is a natural gift, yet an æsthetic rule may be most useful to those not so highly favored, and surprising results developed.

The juxtaposition of two colors nearly alike is distasteful to the eye, and, as adjacent notes sounded together, produce discord; suggesting that the indifference of yellow to green, red to orange, or blue to violet, is like the "beats" produced by sounding C and B together — the result of "*Interference.*"

To this is due the green appearance of blue when strongly contrasted with yellow or viewed in a yellow light, and the likeness of purple to red when placed in proximity to blue.

Colors have a knack of calling out — or, more correctly, *intensifying*—their complementary colors from white. This should be borne in mind in the choice of dress, and those colors avoided whose opposites are unbecoming to the complexion of the wearer. A red dress is apt to tinge a pale face with green, and a purple dress to render it yellow.

In practically working out this theory, and translating the mental music of a group of colors into the audible music of life, the suggestion may be valuable that the instrument most capable of producing parallel sensations is the Organ; the "Diapasons," the "Flute," the "Principal," and the "Swell," being necessary to represent Loudness, Force, and the Tone of pictorial effect.

Colors vary as much in *quality of tone* as do sounds of musical instruments. C on the Trumpet and on the Flute are the same note, yet how different in character and effect!

The Organ represents most instruments in imitation by its stops varying from the "15th" to the "stop diapason"; one being soft, another sweet, another coarse.

With Colors this is perhaps the most difficult subject in the whole inquiry; for whatever quality may be observed in a single Red, Crimson, Scarlet, Indian Red, or any other kind, a similar quality should pervade its own scale, and all the other colors should be akin to it.

Shades or gradations of color may be symbolized by semitones; thus C-sharp for cherry-color, F-sharp for greenish-blue, and so on.

The expression to be conveyed will regulate the choice of key, one with many sharps to signify joy or light and merry movement, whilst a minor approaching as it were by a low wail almost to discord will give the idea of deep and suppressed sorrow.

The pitch in sound, then, has its equivalent in the tint or hue of color; loudness of note corresponding to "loudness" or depth of the color, higher octaves representing fainter and lighter-tinted hues.

Since any two colors complementary to each other produce *white*, white may be harmoniously used with any color; for wherever two such colors may be necessary to complete a full chord, white may be truthfully substituted.

In a general sense, the lower the refrangibility of a color the nearer it will appear to the eye, and the greater the refrangibility the greater the apparent distance. Thus, in Nature, red—the least refrangible color—predominates in the foreground; yellow, green, and the intermediate tints, lie in the middle distance; and blue, with every variety of grey, forms the background of mountains, vapors, and sky.

As in singing it is the invariable custom to add power to the voice in the upper notes of a song, thus producing artificially a larger volume of sound, so in Nature the grey or violet of distant mountains or sky is greatly in excess of the naturally lower and stronger notes of the red cottage-roof, the peasant's cloak, or red tree trunk, that are more forward in position.

In such minute particulars is this analogy of sound and color strengthened that we look in vain to modern scientific researches for counter-evidence.

Certain chemical changes are attended by alteration of color, and when such is the case it invariably occurs in consecutive order, and either ascends or descends the scale; thus the green Iodide of Mercury under the action of heat yields a yellow sublimate, and subsequently becomes red. The red Iodide changes under the same condition from yellow to chrome and from yellow ochre to light-red.

Autumnal tints, descending the scale, may also admit some such analogy of cause and effect.

Spectrum analysis shows that new lines make their appearance in the spectra of certain elements when the temperature is increased. When, for instance, Lithium is heated a splendid blue band is obtaind in addition to the red and orange rays, showing that the undulations of this particular set of vibrations have become more intense.

The same phenomena are observed in the case of the Strontium spectrum, where no less than four red lines (ϵ, γ, κ, λ) make their appearance on increasing the temperature of the metal.

Professor Roscoe* remarks that "The analogy between the production of these more highly refrangible rays and that of overtones, or harmonies of a vibrating string," must be patent.

M. Lecoq de Brisbandeau,† quoting also Plucker and Hittorf, notices similar results with the spectra of Azote, and finds strong analogies to musical harmonies.

From this discovery it is possible that the music of the spheres may no longer remain a mystery; it would only be necessary to write down the score of each star by spectrum analysis, and convert it into the corresponding musical chords, to realize how

> "Each smallest orb * * *
> In his motion like an angel sings."

The sensations of taste and smell may also be the result of appreciated vibrations, and pleasing combinations have some general law of harmonies to govern them.

Between the voice and temper of the speaker an analogy has long been supposed to exist,‡ and indeed theories of the kind have their foundation in scientific fact.

There is an approximation to a law of distances between one planet and another from the primary bearing a strong resemblance to a musical ratio, which gives us some clue guiding us into the Pythagorean idea of the music of the spheres. The distances between Mercury, Venus, the Earth, the group of Asteroids, Jupiter, Saturn, and Uranus, and from the Sun, are closely analogous to the distances between eight octaves in succession. So, too, the four visible moons which revolve around Jupiter bear in the ratio of their revolutions or vibrations to each other a resemblance to harmonical notes. The first moon revolves in 42 hours, the second in 85, the third passes through its phases in 170 hours, and the fourth in 416 hours—giving the following series for the number of hours required for one revolution: 42, 85, 170, 416, the longest time corresponding to the lowest note. By imagining some fixed time wherein to count the revolutions of these satelites, and calculating them for the sake of example by the number of vibrations per second producing musical notes, the second is found to correspond to the octave below the first, the third to the octave below that, and the fourth to the dominant or 5th of the fourth octave below the first.

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* Spectrum Analysis, p. 144.

† On the Constitution of Luminous Spectra. Paris, 1870.

‡ Philosophical Transactions published in 1700. See Curiosities of Literature, by D'Israeli.

Speculations of this kind are necessarily vague, yet not the less truthful. Again and again have the discoveries of a future day been first but dimly seen and faintly outlined. A strong effort of moral courage is required to overstep the bounds of approved philosophy and to start a new theory with all its necessary imperfections and difficulties. "Philosophical guesses" are often censured, and this regardless of the fact that all our best established theories were guesses once. Men in a former era give the clue, others follow it into the Labyrinth. What if some of these guesses prove wrong? The spirit of Investigation, the life of Science is aroused; and if the "Light," Goethe so earnestly prayed for, be given, the silent music of flowers, sunlight, and the stars, may not forever remain unheard.

INTRODUCTION TO SPECULATIVE LOGIC AND PHILOSOPHY.

By A. VERA.

CHAPTER IV. (*Continued.*)

§ 3. *On Ideas as the Essences of Things.*

If we admit that all things rest on a corresponding idea, the next question is whether idea constitutes the essence of things, or whether there is above idea a higher principle, of which idea would be only the *form*—a force, the inward nature of which we are unable to reach, issuing forth from the divine essence, or, to speak more accurately, constituting this very same essence. This is, I need hardly say, the decisive and crowning point of the problem. All those who have sufficiently attended to the subject concur in admitting that ideas are necessary elements of things, that they are eternal